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THE SURGICAL TREATMENT
OF
INTESTINAL PERFORATION
IN TYPHOID FEVER

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THE SURGICAL TREATMENT OF IN- TESTINAL PERFORATION IN TYPHOID FEVER.¹

IT needs no apology from me for bringing before your society for discussion such an important subject as the surgical treatment of intestinal perforation in typhoid fever—a subject of the deepest interest not only to those inclined towards either the purely medical or surgical side of our profession, but also to those who may intend to regard it from the broader standpoint of the general practitioner.

Of all the complications of typhoid fever perforation is the most surely fatal and the one in which surgical interference alone, if we except a very small number of cases of localised peritonitis and abscess, can afford any relief. For the evidence of recovery from perforation in typhoid fever consists almost exclusively in the reports of cases of recovery from peritonitis following so-called symptoms of perforation of the intestine. The so-called symptoms of perforation merely indicate the beginning of peritonitis and may be the result of other local causes than perforation of the bowel. Of such causes may be mentioned softened infarctions of the spleen, perforation of the gall-bladder, rupture of the spleen, rupture of the softened mesenteric glands, abscess of the liver, and salpingitis. Again, numerous fatal cases of peritonitis in typhoid fever have been reported in which no cause for the peritonitis was found. One of the earliest of these was published by Jenner in 1850.² Moreover, perforations of the intestine occasionally occur, simu-

¹ A paper read before the Medical Society, University College, London.

² Medical Times, vol. xxii., p. 405.

lating very strongly typhoid perforation, in which the bacillus typhosus cannot be demonstrated. Cushing³ has observed such a case. The patient, a male, aged 26 years, entered the hospital complaining of severe abdominal distress of 12 hours' duration. He had all the symptoms of a general peritonitis and at the operation a single perforation was found in the ileum two centimetres in diameter and about 30 centimetres from the ileo-cæcal valve. He died six hours later and the necropsy showed an acute splenic tumour, parenchymatous degeneration of the kidneys and liver, with no other intestinal lesions characteristic of typhoid fever. There were no focal necroses in the liver and the bacillus typhosus was nowhere obtained in cultures. After discussing such cases reported as being recoveries from perforation in typhoid fever Fitz⁴ sums up the question in the following words: "Since perforation of the intestine in typhoid fever may take place without any suggestive symptoms, and since suggestive—even so-called characteristic—symptoms may occur without any perforation having taken place, it must be admitted that recovery from such symptoms is no satisfactory evidence of recovery from perforation."

Granted, then, that though recovery without treatment from intestinal perforation in typhoid fever may be devoutly hoped for yet is never to be expected, it behoves us to consider how by active interference we can reduce its death-rate and by what means we can bring this most fatal accident into line with modern surgical methods and place it upon a sound basis of treatment.

Historical.—It is of interest to recall that as early as 1762 Richter, in Vienna, first suggested opening and draining the peritoneal cavity in cases of general suppurative peritonitis. Again in 1816 van Vreeken, in Paris, repeated the suggestion.

Yet 60 years later, in 1876, Kaiser, in Freiburg, was only able to collect 15 cases operated upon up to that time; and of these most were instances of localised peritonitis in women. Von Leyden in 1884 read a paper in Berlin before the Association for Internal Medicine in which he referred to the very unsatisfactory results of the medical treatment and drew

³ Johns Hopkins Hospital Reports, vol. viii., 1900.

⁴ Transactions of the Association of American Physicians, vol. vi. 1891.

general attention to the question whether or not it was possible to treat peritonitis by operation. This was followed a little later in the same year by an exhaustive article by Mikulicz, reviewing the cases operated upon up to that date and reporting one of his own supposed to be due to a perforated typhoid ulcer. In this paper Mikulicz advocated surgical intervention for perforation in typhoid fever in the following words: "If suspicious of a perforation we should not wait for an exact diagnosis and for peritonitis to develop to a marked degree, but on the contrary one should immediately proceed to an exploratory operation, which in any case is free from danger." And finally Wilson of Philadelphia in 1886 foretold our present position in the following impressive words: "The objections which may be urged against laparotomy in intestinal perforation in enteric fever are no more forcible than those which would have been made use of at first against the same operation in gunshot wounds of the abdomen. *The courage to perform it will come of the knowledge that the only alternative is the patient's death.*"

Such appeals were soon to bear fruit, for in 1887 the first operation for the relief of symptoms due to a perforating typhoid ulcer was performed by Kussmaul for Lücke of Strasburg. The symptoms developed on the eighteenth day and the operation was performed 12 hours after their onset. The edges of the ulcer were excised and the opening in the bowel was sutured. Death occurred in a few hours. In the same year and without any knowledge of previous operations of the kind Bontecon of Troy, New York, operated upon a case 36 hours after the onset of symptoms of perforation which occurred in the third week. The patient died without recovering from the anæsthetic. It is of interest to note that in this case the appendix was ulcerated and perforated, as well as the ileum ten inches from the ileo-cæcal valve. In the same year (1887) Bartleet of Birmingham also operated without success. Whether this was a case of perforation or not is doubtful. No perforation was found and while Finney accepts it Fitz rejects it from his compilation.

The first successful case that I can find in Finney's analytical summary⁵ was performed by Wagner in 1889. The patient was a female and the perforation occurred during convalescence. Since then operations have been performed in increasing numbers and with gradually better

⁵ Johns Hopkins Hospital Reports, vol. viii., 1900.

results. Finney⁶ was able to collect in 1899 112 cases of laparotomy for perforative peritonitis in typhoid fever, and Keen⁷ a few months later was able to add 38 more, bringing the total number up to 150. Since then cases are continually being reported from all parts of the world with ever-improving results. So that we are now bound to regard the procedure as one of sound surgery.

Statistics.—Murchison estimated that the mortality of typhoid perforation in general is about 90 per cent., and in those cases in which general peritonitis supervenes after such perforation that it is 95 per cent. The duration of life after symptoms of perforation arise is usually very short. Fitz,⁸ basing his records on 134 cases, found 37·3 per cent. died on the first day, 29·5 per cent. on the second day, and 83·4 per cent. during the first week.

Concerning the frequency of perforation Schulz found that it took place in 1·2 per cent. of 3686 cases of typhoid fever in the Hamburg hospitals in 1886-87. Liebermeister found it in 1·3 per cent. of rather more than 2000 cases in hospital at Basle from 1865 to 1872. Hölscher gives 6 per cent. in 2000 cases. Murchison found 11·38 per cent. in 1721 cases collected from various sources. Fitz in 4680 cases gives 6·58 per cent. Hare gives 20 per cent. and Gessle-witsch and Wanach give 10 per cent. Osler says from 7 to 14 per cent. of typhoid fever patients die, Johns Hopkins Hospital in ten years having a mortality of 63 out of 829 cases, or 7·5 per cent. Of the deaths in typhoid fever Osler says that 50 per cent. are from asthenia, 25 per cent. are from perforation, and 25 per cent. are from hæmorrhage and other accidents. Finney, from a compilation of statistics from various of the best authors, says that perforation occurs in from 1 to 2 per cent. of all cases of typhoid fever. Armstrong⁹ places it at from 2 to 5 per cent. of all cases. Of 932 cases treated in the Montreal General Hospital in the last six years perforation of the ileum occurred in 34 cases or 3½ per cent. Hunter,¹⁰ in an analysis of the cause of death in 50 cases of typhoid fever, says that 48 per cent. died from perforation. In the Maidstone epidemic of 1897

⁶ Loc. cit.

⁷ Philadelphia Medical Journal, Nov. 4th, 1899.

⁸ Loc. cit.

⁹ Annals of Surgery, 1902.

¹⁰ West London Medico-Chirurgical Society, February, 1903.

of 210 cases death occurred in ten, or 4·76 per cent. Out of these 210 cases three patients died from perforation, which gives a rate of 1·42 per cent. of all cases, or 30 per cent of the fatal cases. Taking the Metropolitan Asylums Board reports for the last nine years I find the following percentages of perforation :—

Year.	No. of cases.	Perforation.	Average incidence.
1893	544	23	4·22 per cent.
1894	534	17	3·18 „ „
1895	661	20	3·02 „ „
1896	611	30	4·9 „ „
1897	666	21	3·10 „ „
1898	744	35	4·7 „ „
1899	1383	50	3·6 „ „
1900	1749	46	2·63 „ „
1901	1336	37	2·77 „ „

This gives an average incidence varying between 2·63 and 4·9 per cent. According to Goodall and Washbourn, out of 506 cases at the Eastern Fever Hospital perforation occurred in 16 cases, or 3·1 per cent., so that under modern methods of treatment and good nursing the percentage of perforation may be said to range from 1 to 5.

Sex and age.—Perforation occurs much more often in men than in women. Finney gives the ratio as 3 to 1. Out of 444 cases referred to by Fitz 71 per cent. are among men and 29 per cent are among women. It is very rare in children. Wolberg found no case of perforation among 277 cases of typhoid fever in children in the Warsaw Hospital. In an analysis of 71 cases of typhoid fever treated in the Children's Hospital of Philadelphia during 1901 by Hand and Walker¹¹ no case of perforation occurs. Shattuck, Warren, and Cobb¹² have been able to find but four cases of operation for perforation in children under 12 years of age. One of these is that of a boy, aged nine years, upon whom Cushing performed three laparotomies, with recovery.

¹¹ American Journal of the Medical Sciences, June, 1902.

¹² Transactions of the Association of American Physicians, 1900.

The following table taken from Fitz's paper shows the age at which perforation most frequently occurs :—

Age.	Cases.	Per cent.
1 to 10 years	7	3·6
10 „ 20 „ ...	46	23·8
20 „ 30 „ ...	77	39·8
30 „ 40 „ ...	45	23·3
40 „ 50 „ ...	14	7·2
50 „ 60 „ ...	2	1·0
60 „ 70 „ ...	1	0·5
Total	192	—

In other words of 192 cases over one-third occur in the third decade.

Time of perforation.—Perforation may occur at any period during an attack or during a relapse. The longest reported time after the onset of the disease is Bogart's case¹³ the perforation occurring during a second relapse in the fourth month. The shortest is that in a case reported by Ferrarisi¹⁴ quoted by Finney, in which perforation occurred on the fourth day. In Fitz's table nearly one-half were during the third and fourth weeks. In Finney's table of 79 cases, in 36 cases the perforation occurred during the third week, in 20 during the second week, and in nine during the fourth week. A review of all the cases in which the date of perforation is mentioned shows that the third week of the disease is by far the most frequent time during which perforation takes place.

Seat of perforation.—In Fitz's 167 cases the perforation was in the ileum in 136, or 81·4 per cent. ; in the large intestine in 20, or 12·9 per cent. ; in the vermiform appendix in five, or less than 3 per cent. ; in Meckel's diverticulum in four ; and in the jejunum in two. In Hawkins's 72 cases referred to by Keen¹⁵ the perforation occurred in the ileum

¹³ Annals of Surgery, vol. xxiii., 1896.

¹⁴ Bollettino di Società Lancisiana di Ospedali di Roma, 1896, vol. xv., fasc. 1.

¹⁵ THE LANCET, July 29th, 1893, p. 245.

in 61, in the cæcum in three, in the appendix in three, and in the colon in five. Keen¹⁶ adds five more cases from other sources in which the perforation was in the colon, making ten in all, of which two were in the ascending colon, one was in the transverse colon, two were in the descending colon, and five were in the sigmoid flexure. He therefore concludes that if no perforation is found in the ileum, cæcum, or appendix, the next most likely place will be the sigmoid flexure. In Shattuck's 19 cases the ileum was the place of perforation in all of them. Finney says that it occurs in the ileum, usually in the last two feet, in over 80 per cent. of all cases, in the large intestine in more than 12 per cent., and in the vermiform appendix in about 5 per cent. of all cases. It is usually single but may be double—a point to be borne in mind whenever operative procedure is undertaken. The involvement of the appendix in typhoid fever is of extreme interest and will be referred to later.

Character of the perforation.—The aperture is sometimes exceedingly small and rounded, but may be linear if due to laceration. The perforation may occur in ulcers from which the sloughs have separated, or again, in certain cases the gangrenous process extends directly through the whole thickness of the bowel, and then the slough dropping out may leave a hole of considerable size. According to Osler only rarely is the perforation at the bottom of a clean thin-walled ulcer, the majority being in small deep ulcers. If the ulceration is in a solitary follicle, the perforation is apt to be small and round, while if in a Peyer's patch it may be oval or round and will be much larger than in the former case and may even involve one-half of the circumference of the bowel. The opening may be shreddy or clean-cut. Very frequently there is a fairly wide area around the ulcer in which the intestinal wall has been greatly thinned. From an operative point of view this is of great importance.

Symptoms.—There is no pathognomonic sign of perforation nor is there any definite relation between perforation and the severity of the attack. It occurs in mild cases as well as in severe. Such symptoms as are usually described as being indicative of perforation may be entirely absent or remain latent. On the other hand they may be gradual in onset or appear suddenly. "The so-called characteristic symptoms are not invariably present, and when they are they may be

¹⁶ Surgical Complications and Sequelæ of Typhoid Fever.

so altered or obscured by other conditions that perforation may not even be suspected. The signs upon which most dependence is to be placed are sudden acute pain in the abdomen, with symptoms of collapse, accompanied by an abrupt fall in the temperature, it may be of several degrees. Vomiting is not infrequently present. Various special symptoms have been, from time to time, made much of by writers upon this subject—e.g., the obliteration of liver dulness, the gurgling sound on respiration, hiccough, moveable dulness in the flanks, &c. These, like McBurney's point in appendicitis, are very good signs when present" (Finney).

Cushing¹⁷ calls attention to a "pre-perforative stage," and defines it as "the whole period included between the first involvement of the serosa with the customary formation of adhesions at that point, until these adhesions, which may for a time constitute the floor of the ulcer after the serosa has given way, have themselves become broken down and general extravasation has taken place. This period, as in perforating appendicitis, may last a longer or shorter time and is associated with pain and tenderness and a possible rise in leucocytosis owing to the localised peritonitis." Were it possible to recognise such a "pre-perforative stage" in cases of typhoid fever it is the period in which an operation should be undertaken. For obviously one would then be operating to *prevent* general septic peritonitis and not for its relief, as is the usual procedure in cases of typhoid perforation. It is doubtful, however, whether this stage can be recognised with sufficient clearness to be a positive indication for operation. But if recognised it would certainly justify an exploratory incision under local anæsthesia, a procedure which has been frequently shown to have no untoward effect on the course of the disease.

Unfortunately, the analysis of Shattuck's cases shows that the formation of protecting adhesions in perforation or threatened perforation of the ileum is exceedingly rare. And Monad and van Verts¹⁸ state that adhesions, however slight, almost never occur when the perforation is in the ileum; and, moreover, that peritoneal infection is not always a rapid fulminating affair, but may occur slowly from migration of the bacteria through the necrosed and damaged intestinal coats. Intestinal ulcers certainly may have a pre-perforative stage—i.e., a stage of local peritoneal infec-

¹⁷ Loc. cit., supra.

¹⁸ Revue de Chirurgie, 1897.

tion, whether adhesions exist or not. And that general septic peritonitis in typhoid fever arising from threatened intestinal perforation from the necrosed and damaged areas of peritoneum over the base of ulcers is not a very uncommon occurrence has been shown by Gairdner.¹⁹

Are symptoms ever present then which may be called *warning* symptoms—i.e., symptoms, the advent of which should put the physician on the alert and urge upon him the necessity of calling a surgical *confrère* in consultation? Shattuck from a review of his cases says: "It is rational to conclude that the severe symptoms corresponding to the ordinary text-book picture of intestinal perforation in typhoid were, in the majority of cases, caused by the general septic peritonitis resulting from a perforation or a threatened perforation, the occurrence of which was indicated more or less plainly by symptoms of less severity which antedated the severe or so-called diagnostic symptoms by a definite number of hours." Only five of Shattuck's cases, in which perforation occurred, presented a sudden acute picture of grave abdominal infection *without any premonitory symptoms*. In all the other cases distinct warning symptoms antedated equally distinct severe and diagnostic symptoms. Of Finney's 112 cases, in only nine were the symptoms denoting perforation not marked and of gradual onset. The symptoms most often complained of by the patient are various degrees of abdominal pain and tenderness, either localised or general. A point to be emphasised is that abdominal pain, especially if localised, is not a frequent complaint in mild or moderately severe cases of typhoid fever, unless it means localised or general peritoneal infection, and hence complaints of abdominal pain in such cases should be regarded as serious danger signals. A steadily rising leucocytosis, with localised muscular spasm and tenderness accompanying the pain, are signs of the utmost diagnostic importance. Vomiting is not always present. A rapid drop in temperature is not infrequent and Dieulafoy²⁰ regards it as almost an infallible sign. On the other hand, many cases are accompanied by a rise in temperature. The pulse becomes small and rapid and stands out in sharp contrast to the drop in temperature if present. The respirations become rapid and shallow and chiefly of the costal type. Gairdner²¹ states that rigor as an initial symptom of perforation is

¹⁹ Glasgow Medical Journal, vol. xlvii.

²⁰ Bulletin de l'Académie de Médecine, October, 1896.

²¹ Loc. cit.

uncommon, though Shattuck thinks that if intestinal hæmorrhage can be excluded as its cause it is not irrational to suppose that rigor might be occasionally present as an early symptom.

Concerning the relation of intestinal hæmorrhage to perforation it is obvious that as the former must come through extensive ulceration of the intestinal wall, and since this may mean proximity to the peritoneal coat of the intestine, intestinal hæmorrhage should be regarded in the light of a danger signal of perforation. A close watch should therefore be maintained for signs of beginning peritoneal infection and frequent examinations of the abdomen should be made to detect tenderness or abnormal rigidity, together with repeated blood counts to determine the presence or absence of leucocytosis. Should acute abdominal pain occur with, or follow, intestinal hæmorrhage a grave suspicion of perforation must arise. The most constant symptoms, however, of intestinal perforation in typhoid fever are sudden abdominal pain, increasing in intensity and recurring in paroxysms, general tenderness and rigidity with distension, a rapid, feeble pulse, with signs of collapse and the appearance of leucocytosis.

Leucocytosis.—In discussing the probable value of examinations of the blood in arriving at a diagnosis of intestinal perforation in typhoid fever it is necessary to have some knowledge of the effect that the disease *per se* has upon the leucocytes. Estimating the normal number of colourless corpuscles at about 7500 per cubic millimetre, it has been found that the number throughout an attack of typhoid fever is subnormal. There is a gradual diminution after the first week, the lowest point being reached about the fifth week. After a temporary rise in the sixth, seventh, and eighth weeks there is a tendency to even a further reduction. This temporary rise in these weeks is explained by the fact that at this period the patient is especially open to a variety of secondary infections and intoxications. Again, various transient influences may cause a degree of increase in the number of leucocytes considerably greater than any possible decrease. Thayer²² concludes from his very accurate and painstaking observations that the number of colourless corpuscles is subnormal throughout the course of typhoid fever, the figures becoming

²² John Hopkins Hospital Reports, vols. iv. and viii., 1900.

lower with the increase in the duration and intensity of the disease; that the longer and more intense the infection the smaller the number of leucocytes; that the average number of colourless corpuscles at the height of the fever is about 5000, though in individual cases it is common to find as few as 4000 or 3000, while records below 3000 are not unusual; and that with convalescence the number of leucocytes gradually rises, remaining, however, somewhat subnormal during the first several weeks. Thayer definitely refutes the idea held by some observers that an initial leucocytosis occurs during the first week.

Systematic examinations of the leucocytes are now regarded by many surgeons as especially important in connexion with the early detection of perforation, the diminished number of colourless corpuscles during typhoid fever contrasting sharply with the leucocytosis which might be expected with a general peritonitis. The question is how far can leucocytosis be relied upon as a diagnostic sign in favour of a perforation having occurred and what value are we to place on its absence when a perforation is suspected. As to its diagnostic value, it is unquestionably great, more particularly when taken in conjunction with other symptoms already mentioned. Of course, one isolated examination is of no, or of very little, value, though in any doubtful case, if time allows, a count should be made in order to assist in diagnosis. To obtain its full value, however, systematic examination of the blood from the beginning should be made in every case of typhoid fever. In 1897 Cabot noted the fact that leucocytosis in typhoid fever means inflammatory complications in the majority of cases and that it was present in peritoneal infection. He has since pointed out that it does occasionally happen in very exhausted patients that complications fail to produce any leucocytosis, the patient being unable to react against the infection, but that these cases are exceptional. Cushing's conclusions²³ on the subject are of especial value and importance, seeing that they are founded on actual surgical experience. He says: "The appearance of leucocytosis in the course of typhoid fever points toward some inflammatory complication in its early stage. If this complication be a peritonitis and remain localised, associated possibly with a pre-perforative stage of ulceration or with a circumscribed slowly-forming peritonitis after perforation, it may be, and usually is,

²³ Johns Hopkins Hospital Reports, loc. cit. supra.

signalised by an increase of leucocytes in the peripheral circulation. If, however, a general septic peritonitis follow, the leucocytosis may be but transitory and overlooked, as it disappears concomitantly with the great outpouring of leucocytes into the general cavity." Whether absence of leucocytosis in the presence of symptoms of peritonitis means in every case that general peritonitis has become well advanced has not been actually proved. While a complete knowledge of leucocytosis in the perforation peritonitis of typhoid fever is yet to be reached, still it is certain that careful and frequent blood counts in a typhoid fever patient suffering from abdominal pain may give most valuable evidence of the commencement of peritoneal infection.

Diagnosis.—It is of the greatest importance, if surgery is to have a fair chance of saving life, that a diagnosis of infection of the peritoneum should be made within a sufficiently reasonable time from its commencement. And yet the fact that in 11 per cent. of the cases collected by Finney a wrong diagnosis was made shows that the recognition of perforation of the bowel in the course of typhoid fever is not always easy. Appendicitis and intestinal obstruction are the affections for which it is most commonly mistaken. Fitz was the first to call attention to the similarity of the symptoms of perforation in typhoid fever and those of appendicitis. He even goes further and says that they are actually identical, even to the usual localisation of the consequent peritonitis in the right iliac fossa. Dieulafoy²⁴ describes two distinct forms of typhoid appendicitis, both producing peritonitis. One he calls "peritonitis by propagation," the other "para-appendicitis." In the former the appendix becomes the seat of typhoid lesions, with ulceration, perforation, and peritonitis. The symptoms in this case exactly resemble perforation in other parts of the intestine due to typhoid ulceration. The latter form of appendicitis is a true appendicitis of the usual variety with the ordinary symptoms and possible complications of that disease. Hare²⁵ also refers to two groups of cases: (1) those cases in which symptoms developing in the neighbourhood of the appendix indicate the rapid development of appendicitis, yet in which these symptoms gradually subside and the patient passes into an attack of typhoid fever; and

²⁴ La Presse Médicale, October 28th, 1896.

²⁵ Transactions of the Association of American Physicians, 1900.

(2) cases already well advanced in the progress of typhoid fever which develop appendicular symptoms.

Osler thinks that perforation of the appendix in typhoid fever is not very common, as shown by Fitz's 3 per cent. in 167 cases. Cushing, however, thinks it much commoner than is usually supposed and gives 9.6 per cent. from his collected cases. Whether we have to do with a perforation of the appendix or of another part of the bowel in typhoid fever chiefly concerns the question of prognosis, as pointed out by Fitz²⁶ who remarks : "Clinical evidence, on the contrary, though perhaps misunderstood, is abundant as to the probable frequency of perforative appendicitis in typhoid fever. The probability of its occurrence furnishes the best solution as to the prognosis of intestinal perforation in the latter disease. Most of the cases of recovery from symptoms of perforation of the bowel in typhoid fever are those in which an attack of appendicitis is closely simulated, while the fatal cases of perforation of the bowel in typhoid fever are in a great majority of instances those in which other parts of the bowel than the appendix are the seat of the perforation ; hence the prognosis of apparent perforation of the bowel in typhoid fever is to be regarded as the more favourable the more closely the symptoms and course resemble those of an appendicitis." The conclusions arrived at by the Boston Committee, which includes the names of such authorities as Shattuck, Collins Warren, and Cobb, are well worth recording upon this point and are as follows : "It is imperative that we should not be prevailed upon to wait operation in the hope that the perforation may be in the appendix, considering that the chance of localising the infection by delay offers more hope to the patient than speedy operation, because the attack began with right iliac pain and tenderness and muscular spasm. The better teaching is that perforation of the appendix may occur in typhoid, although *rarely* ; that when it does occur the infection may be localised, as in any case of perforating appendicitis. But the great majority of cases of perforation of the bowel in typhoid fever may simulate an acute appendicitis."

Prognosis.—In trying to arrive at some definite conclusion concerning the prognosis of the operative treatment of perforation in typhoid fever we are met with the difficulty that two very different and widely separate conditions are

²⁶ Loc. cit.

considered together in the statisticians' tables—viz., one the results of operation for typhoid perforation, and the other the results of operation for general peritonitis following typhoid perforation. In the latter case the prognosis is invariably bad, as shown by the reports of the Metropolitan Fever Hospital for 1901. Ten laparotomies for "perforation in typhoid fever" were performed, none of the patients recovering. But, and this is the important point, all were found at the time of operation "in a state of general septic peritonitis"; so that the operations were really undertaken for the relief of general septic peritonitis and not for the perforation. As in other intra-abdominal catastrophes, so in perforation in typhoid fever, early diagnosis and early operation will greatly improve the prognosis, and in the latter condition, according to Osler, may save from 30 to 40 per cent. of the cases. In Armstrong's cases²⁷ there were six recoveries in 33 cases, or 18·18 per cent. In ten cases operation was performed during the first 12 hours with four recoveries—i.e., 40 per cent.; in ten cases during the second 12 hours with one recovery—i.e., 10 per cent. Of the 20 cases operated upon in the first 24 hours five patients recovered—i.e., 25 per cent.; of three cases in the third 12 hours all the patients died. Of five of his recoveries the time after the perforation at which operation was performed was 2, 13, 8, 10, and 5 hours respectively. The following table, showing the percentage of recoveries according to the time after perforation at which the operation was performed, is taken from cases collected by Keen²⁸ :—

—	Died.	Recovered.	Percentage of re- coveries.			
Under 4 hours ...	6	1	14·3	} 17·6	} 10·5	} 24·06
4 to 8 „ ...	11	1	8·3			
8 „ 12 „ ...	11	4	26·6			
12 „ 18 „ ...	17	7	29·1	} 31·4	} 30·1	
18 „ 24 „ ...	7	4	31·4			
Over 24 „ ...	38	14	10·0			
Not given	28	11	28·2			
Total	118	34	22·7			

²⁷ Annals of Surgery, November, 1902.

²⁸ Philadelphia Medical Journal, November, 1899.

i.e., the recovery-rate for the first four hours is 14·3 per cent. ; for from four to eight hours, 8·3 per cent. ; and for all cases operated upon within the first eight hours the recovery-rate is 10·5 per cent. In the cases operated upon from 8 to 12 hours the recovery-rate rises to 26·6 per cent., which is below the recovery-rate of operations done from eight to 24 hours, which is 31·1 per cent., or in the second 12 hours, which is 31·4 per cent. After 24 hours the recovery-rate falls to 10 per cent.

The rapid improvement which has taken place in the recovery-rate is well shown by comparing that given by Keen in his book, published in 1898, and in his paper of November, 1899. In the former he collected 83 cases of operation, with 67 deaths and 16 recoveries, the recovery-rate being 19·3 per cent. In the latter he appends 67 additional cases in which there were 49 deaths and 18 recoveries, with a recovery-rate of 26·9 per cent.—i.e., a gain over the recovery-rate of the first 83 cases of almost 40 per cent. The recovery-rate of the whole 150 cases is 22·7 per cent. Up to Jan. 1st, 1900, 11 cases in Osler's wards had been operated upon with five recoveries—i.e., 45·4 per cent. Age, though no barrier to operation, apparently has a considerable influence upon the recovery-rate, as shown by the following table, taken from Keen's paper :—

Age.	Recovered.	Died.	Percentage of recoveries.
Under 15 years	6	6	50·0
From 15 to 25 years	5	34	8·1
„ 26 to 35 „	10	29	26·5
Over 35 years	6	15	38·5

From this it would appear that between 15 and 25 years is the most unfavourable age at which to operate, whilst the most favourable are over 25 years and especially under 15 years. Sex would also seem to have an influence upon the recovery-rate judging from various statistics. Of Armstrong's cases quoted above 21 males were operated on, and three, or 14½ per cent., recovered ; and nine females, of whom three, or 33½ per cent., recovered. In Keen's cases in which the sex was mentioned 102 were males and 19 were females—i.e., 84 per cent. of

males. Of the males 83 died and 19 recovered—a recovery-rate of 18·6 per cent. Of the females 11 died and eight recovered—a recovery-rate of 42·1 per cent. In other words, while the number of operations in males has been over five times as many as in females, yet the recovery-rate of females has been over twice that of males. Regarding the recovery-rate in the various weeks of the disease, although the mortality-rate of the second and third weeks is by far the worst yet even these two weeks give a recovery-rate of over 16 per cent. in Keen's cases. As regards results of surgical procedure Osler groups the cases under three classes : (1) those with so much infiltration and necrosis that the gut is not in a fit state for operation and the condition of the patient may contra-indicate any attempt at resection ; (2) the operation is successful but the patient dies in the due course of the disease from the intensity of the fever or in a relapse ; and (3) those in whom complete recovery takes place.

Concerning the prognosis of the future no one states the case more plainly than does Keen²⁹ in the following words : "When once physicians are not only on the alert to observe the symptoms of perforation, but when the knowledge that perforation of the bowel can be remedied by surgical means has permeated the profession, so that the instant that perforation takes place the surgeon will be called upon, and if the case be suitable, will operate, we shall find unquestionably a much larger percentage of cures than have thus far been reported."

Treatment.—The only rational treatment of intestinal perforation in typhoid fever is a surgical operation. That this dictum has now finally become accepted is nowhere better shown than in the articles on the subject by such an authority as Goodall in the last three issues of the *Medical Annual*. In that of 1901 no mention of surgical intervention is even hinted at. In that of 1902 we read : "The question is still being debated whether, and if so when, laparotomy should be resorted to." In that of 1903 we find any lingering doubts on the subject dissipated in the following sentences : "There is a pretty general agreement that if perforation occurs surgery does offer the best chance of recovery. I think, further, that there can be no question that the percentage recovery of the cases submitted to operation is *very* much larger than that of those left to themselves. But in

²⁹ Loc. cit.

spite of our own want of success in the small number of cases I am perfectly sure that as soon as a perforation is diagnosed laparotomy should be performed and it should be undertaken either immediately or as soon as the condition of the patient permits."

In cases of suspected perforation in which it is impossible to arrive at a diagnosis in any other way a small exploratory incision, preferably under local anæsthesia, should be made. Such a procedure has been shown to have no untoward effect on the ultimate course of the disease. It is better to operate needlessly if it so be than to wait for general septic peritonitis to declare itself. There is one very important point, however, in the treatment of cases of suspected perforation upon which too much stress cannot be laid—that is, the administration of opium or morphine. "The use of opium in these cases is justifiable only *after* the diagnosis has been made and operation decided on."³⁰

The operation for intestinal perforation in typhoid fever in no way differs in its main features from that undertaken for intraperitoneal perforation from other causes. Three steps follow each other in natural sequence—viz., (1) finding and closing the perforation; (2) emptying and cleansing the peritoneal cavity; and (3) establishing and maintaining proper drainage. Two other points should always be remembered—viz., (1) that there may be more than one perforation present and search should be made for it and for other ulcerations likely to perforate; and (2) that it is necessary to examine the appendix before closing the abdomen as typhoid ulcers sometimes occur there.

As to the time of operation after perforation occurs surgeons differ. Keen advises waiting until the shock, which he ascribes to pain and extravasation, has passed off. Cushing, on the other hand, very aptly points out that while we are waiting extravasation, perhaps of virulent organisms, is continually taking place and hence shock seems hardly a contra-indication to operation. Lennander³¹ writing on the subject discourages delay and even regards the anæsthesia and operation as a means of combating shock. The majority of surgeons would now appear to advocate early operation.³² The position of the abdominal

³⁰ Osler in Nothnagel's *Encyclopædia of Medicine*.

³¹ Observations on the Sensibility of the Abdominal Cavity, *Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie*, March, 1902. Barker's translation.

³² Armstrong, Finney, Shepherd, Waring, Roughton, Bowlby, and Cushing.

incision (generally in the right iliac region), the form of suture used, the method of cleansing the peritoneum, the question of drainage, the employment of a general or local anæsthetic, all these will be decided by the experience of the individual operator. While resection of the ulcerated portion of the bowel with immediate end-to-end anastomosis would be the ideal operation, it can scarcely ever be feasible. The suturing should be done without paring of the edges—a needless prolonging of the operation—and all of the thinned area should be included in the suture, care being taken, however, to avoid inverting too much, lest too great a narrowing of the lumen take place. Whether the suturing be parallel to the axis of the bowel or at right angles to it, would appear to be immaterial and will be governed by circumstances. Early operation and rapidity of operation, without however sacrificing thoroughness, are the two main essentials for success.

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